THE THAUMASIA "RIFT", MARS – IS IT A RIFT? E. Hauber[1] and P. Kronberg[2], [1]DLR-Institute of Space Sensor Technology and Planetary Exploration, Rutherfordstr. 2, 12489 Berlin, Germany; Ernst.Hauber@dlr.de, [2]Institute of Geology and Paleontology, TU Clausthal, Leibnizstr. 10, 38678 Clausthal-Zellerfeld, Germany.

Summary: We describe the morphology of a large and complex graben structure in the western Thaumasia region (the "Thaumasia graben" [1] or TG). We consider possible fault geometries, determine extension, and discuss shortly possible models for its origin.

Background: Situated at the western border of the Thaumasia plateau, the TG is one of the most prominent fault-bounded structures on Mars. It is ~100 km wide, >1000 km long, and strikes N15°-20°W (Fig. 1a). Several authors [e.g., 1,2,3,4] ascribe it to rifting, while others [5,6,7] favour right-lateral strike-slip faulting accomodating a relative motion of Thaumasia toward SE. Roof collapse after late-stage magma withdrawal from Syria Planum has also been hypothesized [8]. The TG formed during the last stage of Thaumasia tectonics, probably in Late Hesperian [9] or Early Amazonian [2]. It is superimposed on the Early Noachian tectonic center of Claritas (27°S, 106°W [10]).

Architecture: Principal morphotectonic features of the TG and adjacent areas are (Fig.1a): (i) smooth lava plains of Syria Planum, bordered to the W by (ii) an escarpment made up by an *en echelon* series of steeply W-dipping faults marking the eastern border of the TG, (iii) the graben floors of segments A and B (see Fig. 1b for location), and (iv) the curvature of steeply E-dipping faults at 18-21°S, defining the master faults of segment A and separating it from a topographical high towards NW. Between 22°S and 33°S, the western border fault system is more diffuse.

Extension across segment A has been accomodated by an asymmetric (half)graben about 150 km in length and 100 km in width. Steeply E- to SE-dipping normal faults with fault length segments of 50-80 km and displacements of 2.0 km form the master fault system (profile 2, Fig. 1c). The graben is characterized by step-fault platforms with displacements of up to 150 m on antithetic faults. Internal block faulting is often controlled by reactivated trends of older fractures.

At 21°S, the master fault changes over to the E-flank of the TG, and the elevation of the graben floor decreases to elevations 3500-4000 m. Segment B is about 250 km long and up to 100 km wide. As shown by profile 3 (Fig. 1c), the graben floor is tilted towards the steeply W-dipping normal (planar) border fault system. Master fault lengths range from 50-80 km and observable throws from 1.5-2.2 km. MOLA data suggest limited block rotation on synthetic normal faults.

Where the TG enters more rugged Noachian terrain at 25°S (segment C), its configuration becomes less evident than in segments A and B. Steeply W-dipping faults dominate the eastern border, with fault lengths of 50-90 km and observable displacements from 1.3-2.0 km. While the master faults of the eastern graben flank can be traced over >500 km along strike, the structure of the western flank is rather inconspicious.

South of ~24°S, the TG crosses some WNW/ESE striking topographic highs of rugged Noachian terrain, (Fig. 1b). They represent a so far undescribed continuation of the ancient highland belt toward NW, where it is successively buried under younger Tharsis lavas. Segment C is superimposed on the belt. The pre-graben relief with its NW-trending highs and lows affected local graben development of the TG.

Fault geometry – planar or listric? Several profiles across the TG display features that might indicate a listric master fault, including an overall halfgraben geometry, tilted blocks, and an (albeit slight) curvature of the hanging wall which is characteristic of a roll-over (e.g., profile 3 in Fig. 1c). For a listric fault, the depth D to a detachment can be determined from the dip of the master fault at the surface (α), the tilt of the graben floor (θ), and the vertical offset (d) (equation 12 in [11], cited in [12]). We measure a scarp height d of ~2000 m and floor tilts θ between 0.9° and 2.7°. For $\alpha = 60°$, we obtain values of D between ~33 km and ~67 km ($\theta = 2.0°$ and 1.0°). Interestingly, these values correspond very well with recent estimations of the thickness of the elastic lithosphere T_e in S-Tharsis as given by [13] (Valles Marineris: ~60 km, Solis Planum: ~35 km) or [14] (<70 km). A listric master fault might indicate gravitational gliding of an unstable part of the outward verging fold-and-thrust plateau margin [15] towards W, i.e., toward the foreland of Thaumasia. However, slip along planar faults can also produce tilted graben floors [16] and hanging wall flexure [17], so the observed morphology does not allow any firm statement about the fault geometry.

Extension: …was determined using the vertical displacement at fault scarps (see companion abstract [18]). In the N, most of the extension has occurred along a few major faults. In the S, it has been distributed among many smaller faults. Extension is 0.5 to 3.5 km, (strain 1 to 3%). This is much less than 10 km, as calculated by [19] from scarp widths and shadows.

Discussion: While the structural geometry of the TG is more similar to classical rifts than that of Valles Marineris, there are better Martian analogues to terrestrial rifts (e.g., Tempe Fossae [20]). Essential characteristics of continental rifts are: Regional domal uplift, crustal break-up, formation of through-going rift valleys, and rift-related volcanism. The structural setting and the morphotectonic features of the TG and the lack of extension-related volcanism do not meet these criteria of terrestrial continental rifts. So far, the geodynamic processes that led to the formation of the TG are unclear (crustal break-down due to structural uplift of Thaumasia? magma deficit near Syria Planum? a long-lived and late center of magmatectonic activity?).

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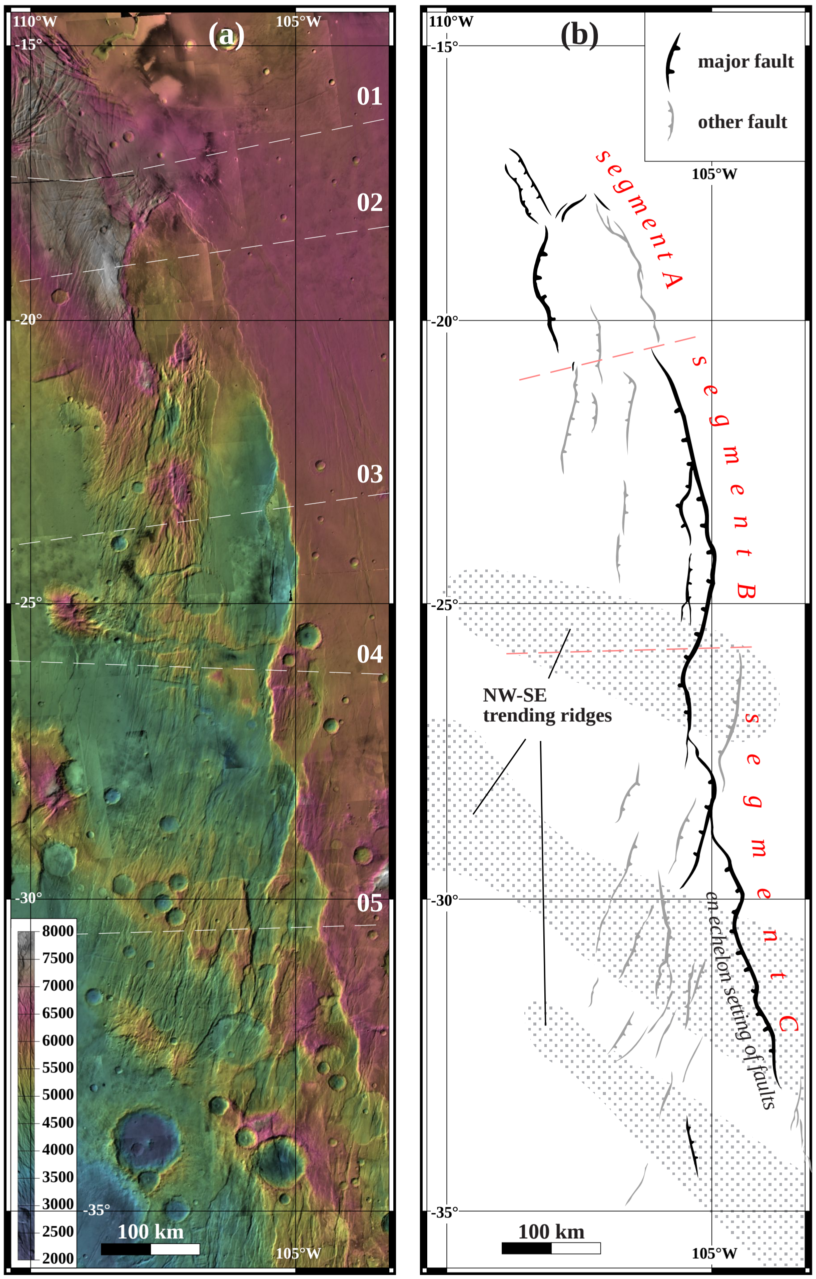

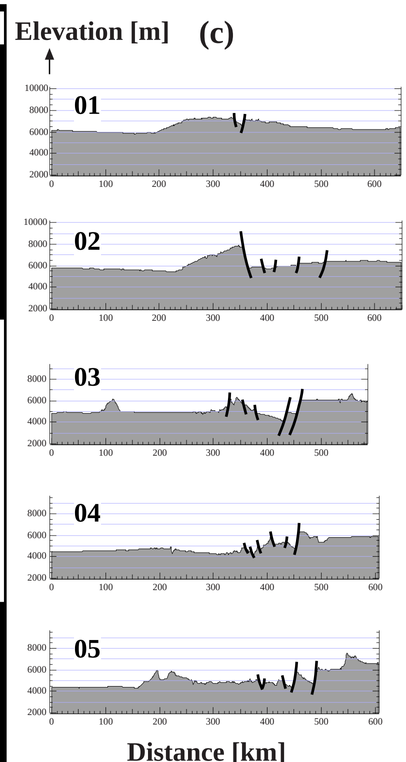

Figure 1: (a) Topographic image map of the Thaumasia graben (TG). Dashed white lines show locations of profiles (Fig. 1c; start and end points of profiles are outside image area of Fig. 1a). (b) Tectonic sketch map. Major (master) faults in black. Note the *en echelon* geometry of the master fault system in segment C. (c) Topographic profiles derived from a MOLA-based gridded DEM. Inferred major normal faults are shown as solid black lines. Vertical exaggeration is 20 : 1.